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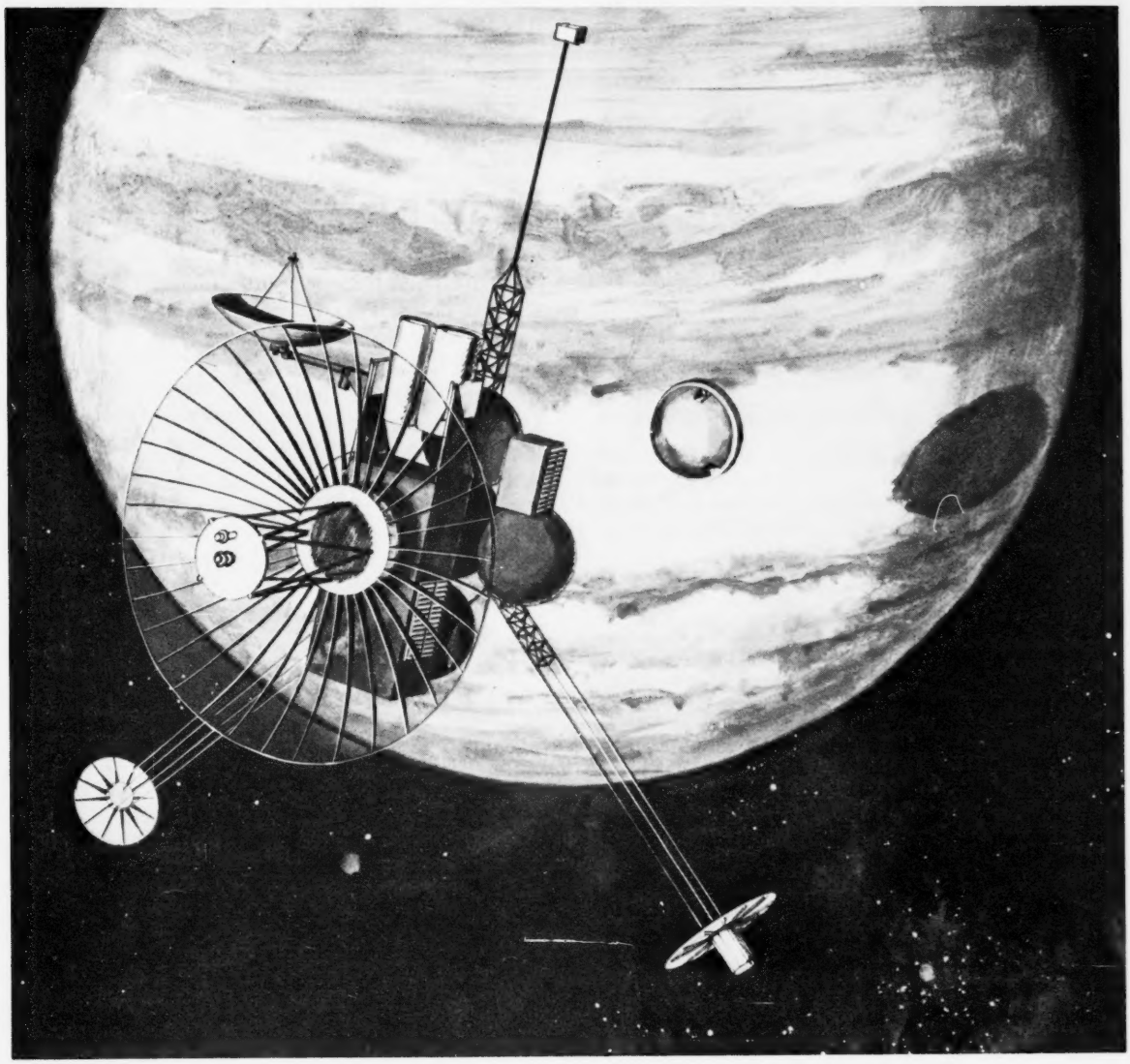

Cover

Closing in on Jupiter—In this drawing, the probe portion (disk at right of the orbiter) of the Jupiter Orbiter Probe satellite has been launched toward the giant planet. Launch of the spacecraft is tentatively scheduled for January 1982, with flight time estimated at 1,000 days to the target. Under the direction of NASA's Jet Propulsion Laboratory, the orbiter would release the probe 56 days before reaching Jupiter so that it would enter the planet's atmosphere on the sunlit side, taking measurements of Jupiter's atmosphere during the 30-minutes of descent. The orbiter would then go on to circle Jupiter for at least 20 months, studying the planet, its largest satellites, and the entire Jovian environment.

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Fifth Intelsat IV-A Launched

The fifth Intelsat IV-A commercial communications satellite was launched by NASA aboard an Atlas Centaur rocket from the Kennedy Space Center, on Jan. 6, 1978. The satellite, which weighs 1,515 kilograms at launch, is intended for service in the Indian Ocean region.

Intelsat IV-A(F3) satellite operates in geostationary orbit over the Indian Ocean at 63 degrees East longitude, to provide international communications services to some 40 countries in the Indian Ocean region. The satellite has a seven-year design life and the capacity to relay more than 6,000 simultaneous telephone calls and two television programs.

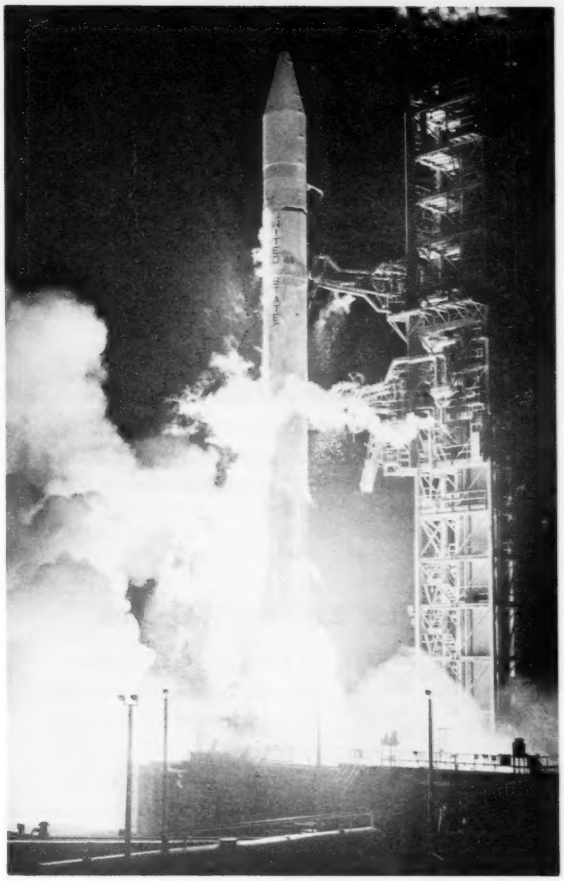
The Intelsat satellites are owned by the International Telecommunications Satellite Organization (Intelsat). The Communications Satellite Corp. (Comsat), the United States member, is also the management services contractor for the satellite system. NASA is reimbursed for all costs of the Atlas Centaur and launch service by COMSAT on behalf of Intelsat, under provisions of a launch services agreement.

The Atlas Centaur AC-46 launch vehicle places the Intelsat IV-A in a highly elliptical orbit of 548 by 35,940 kilometers. After reorientation of the satellite, a solid propellant rocket motor aboard the spacecraft was fired to circularize the orbit at synchronous altitude over the equator. At that altitude, because the speed of the spacecraft in orbit matches the rotational speed of the Earth, the satellite remains in position over one location.

The launch of Intelsat spacecraft aboard Atlas Centaur rockets requires the coordinated efforts of a large government and industry team. NASA's Lewis Research Center has management responsibility for the Atlas Centaur development and operation. NASA's Kennedy Space Center is assigned vehicle checkout and launch responsibility once the vehicle has arrived at Cape Canaveral.

The Intelsat IV-A satellites, built by Hughes Aircraft Co., El Segundo, Calif., are 6.98 meters tall and weigh 1,515 kg at liftoff and 825.5 kg after apogee motor firing.

The Intelsat IV-A program represents an investment by 101 nations of about $295 million (U.S.). The Jan. 6 launch cost some $47 million—$18 million for the satellite and $29 million for the Atlas Centaur launch vehicle and related services.



First 1978 Launch—Intelsat IV-A was successfully launched on Atlas-Centaur 46 at 7:15 p.m. EST, Jan. 6, 1978. In synchronous orbit, the spacecraft will provide commercial communications service in the Indian Ocean area.

A Call for Space Literature

NASA *Activities* recently received a request for written material about the Moon landing from the editor of the University of Michigan's *Quarterly Review*. The following quotes delineate his requirements:

"The *Michigan Quarterly Review,* formerly a literary magazine, has become an interdisciplinary journal devoted to exploring significant issues. The spring 1979 issue will be devoted entirely to the theme, 'The Moon Landing and its Aftermath.' I hope to assemble as much as 200 pages of essays, memoirs, interviews, fiction, poetry, graphic works—writing in any literate form—that will illuminate the last decade of space consciousness.

"I'm certain that many of your readers have given a great deal of thought to subjects pertaining to the

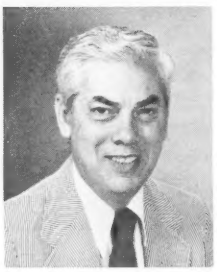
Apollo flights and their importance. I'm looking for work that is thoughtful, original, a new perspective on a much publicized event. Not public relations material but creative, individual responses.

"We welcome material of any length, though anything beyond 30 typed pages stands a poor chance of being selected. All manuscripts must be accompanied by a stamped, self-addressed envelope. Payment is on acceptance and runs about $5 to $8 a printed page. Deadline is Nov. 1, 1978.

"I'm interested also in graphic materials, particularly photographs, previously unpublished, to accompany the tests."

Submissions or requests for additional information should be sent to: Laurence Goldstein, Editor, Michigan Quarterly Review, 3032 Rackham Bldg., Ann Arbor, Mich. 48109. Telephone number is (313) 764-9265.

New Chief for External Relations



Kenneth R. Chapman became NASA's Associate Administrator for External Relations, on Jan. 8, 1978. Chapman has been acting Associate Administrator for External Relations since the position was created on Nov. 8, 1977. Previously he was Assistant Administrator for DOD and Interagency Affairs.

As Associate Administrator for External Relations, Chapman will be the senior policy official responsible for integrating NASA's activities in matters concerned with the legislative branch, universities, communities, other agencies and the international community.

Chapman came to NASA from the Nuclear Regulatory Commission, where he had been director of the office of nuclear material safety and safeguards since he retired in 1975 after a 29-year career in the Air Force.

A native of Summerfield, Kan., Chapman attended Kansas State University at Manhattan from 1941 to 1943, entered the U.S. Military Academy at West Point in June 1943, and graduated in June 1946 as a second lieutenant with a pilot rating. In 1952 he entered the University of California at Berkeley and in 1954 received a master of science degree in nuclear chemistry. During 1963 he attended the Armed Forces Staff College at Norfolk, Va., and graduated from the Industrial College of the Armed Forces, Washington, D.C., in 1966.

1978 Launches

NASA's launch schedule for 1978 represents a heavy workload for expendable vehicles throughout the year, with 25 launches on the calendar. Eleven will use Delta launch vehicles, eight will use Atlas Centaurs. On three of the launches, NASA personnel will provide support for Atlas-F vehicles from Vandenberg Air Force Base.

The schedule began with three launches in January to be followed by three or more in other months.

Most of the launches emphasized the use of space for the direct benefit of people on Earth, such as communications, geodetic, environmental, navigation, meteorological and Earth resources. In 1978, missions will be divided evenly between those concerned with human applications and those devoted primarily to scientific and exploratory research.

Fifteen launches will be for paying customers, including the European Space Agency, Comsat Corp., the U.S. Navy, the National Oceanic and Atmospheric Administration, Japan, the United Kingdom and Canada.

Ten of the Deltas will be launched by the Kennedy Space Center (from the Cape Canaveral Air Force Station) and one from the Western Test Range launch pad at Vandenberg AFB. All the Atlas Centaurs will be launched from complex 36 at the Cape.

The first launch of the year was Intelsat IV-A (F-3) on Jan. 6, one of a series of International Telecommunications Satellite Organization spacecraft, on an Atlas Centaur. A second, Intelsat IV-A (F-6), may be launched in February.

A second Atlas Centaur carrying FLTSATCOM-A, the first of a series of geosynchronous orbiting spacecraft in a new Navy worldwide communications system, took place Jan. 27.

An International Ultraviolet Explorer (IUE) was sent aloft on a Delta from Cape Canaveral on Jan. 26. In geostationary orbit above the equator, IUE will obtain data on ultraviolet emissions from stars and other stellar sources. The spacecraft was built at NASA's Goddard Space Flight Center. The European Space Agency and Great Britain's Science Research Council will participate in IUE experiments.

Landsat-C is scheduled for launch on a Delta from Vandenberg on March 5. The picture-taking satellite will join Landsat-1 and Landsat-2 in polar orbit to expand NASA's program for cataloging the Earth's resources and monitoring changing environmental conditions.

Launch of an experimental broadcasting satellite, Japan-BSE, for research leading to the orbiting of future large-scale broadcasting satellites by the island nation, is scheduled on a Delta from Cape Canaveral on March 23.

The launches of Intelsat IV-A (F-6) on an Atlas Centaur and a backup ESA Orbital Test Satellite on a Delta from Cape Canaveral are scheduled in April. An earlier attempt to orbit an OTS failed when Delta-134 exploded shortly after liftoff Sept. 13, 1977.

Pioneer Venus-A, the first of two missions to examine the Venusian atmosphere and the planet's weather, is scheduled for launch on an Atlas Centaur in May. The mission of Pioneer Venus-A is to place its spacecraft in orbit to study the upper atmosphere.

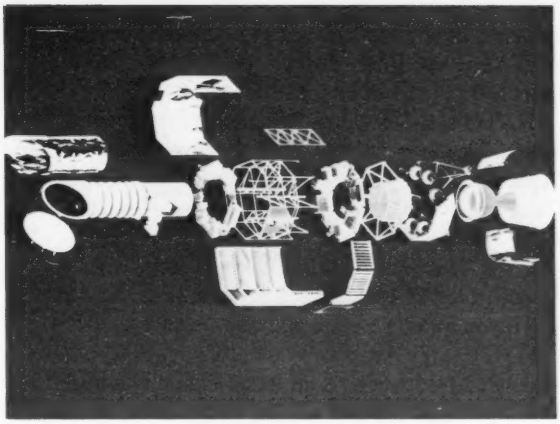
Pioneer Venus-B will be launched on an Atlas Centaur in August. A multi-probe, it is scheduled to enter the Venusian atmosphere six days after arrival of the orbiter. The spin-stabilized multi-probe spacecraft consists of a bus, a large probe and three identical small probes, each with scientific instruments.

The probes will be released from the bus 20 days before arrival at Venus. The large probe will conduct soundings of Venus' lower atmosphere, measuring clouds as well as atmospheric structure and composition. The smaller probes, entering at widely separated points, will provide information on the general circulation patterns of the lower atmosphere.

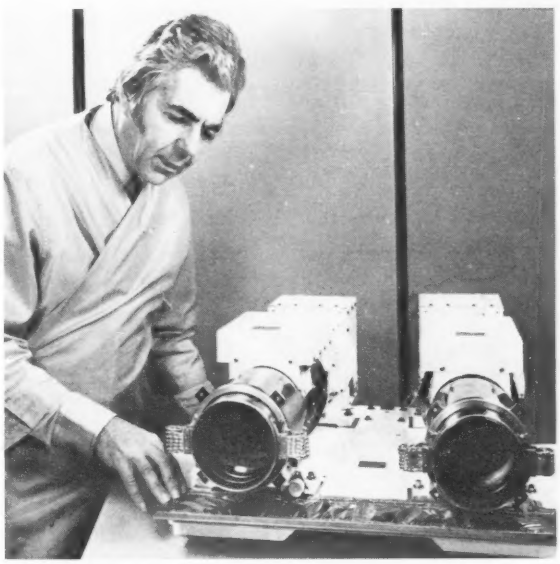
A Japanese spacecraft that would be launched on a Delta from Cape Canaveral (if an earlier Japanese mission is not successful) is on the schedule for June. If the Japanese spacecraft is not required, ESA GEOS-2, a scientific satellite, will be launched on a Delta in June. GEOS-1, launched from the Cape last April 20, did not reach its intended orbit, although the spacecraft is transmitting data back to Earth and the mission is listed as partially successful.

Comstar-C, a domestic communications satellite, will be launched for COMSAT General Corp. on an Atlas Centaur in April.

Also scheduled for July launch is International Sun Earth Explorer-C (ISEE-C) on a Delta from Cape Kennedy. ISEE-C will be orbited at the libration point between the Earth and the Sun, a point in space where the force of gravity and dynamic force exert an equal pull. From there it will obtain data on solar wind similar to, but from a different location than those



The Bits and Pieces that Form a Satellite—This artist's concept shows how the International Ultraviolet Explorer (launched in early 1978) looked before it was put together and made ready for orbital flight. Once in space, the IUE will be looking at distant galaxies, the space between galaxies, exploding galaxies, quasars, pulsars, neutron stars, binary star systems, hot and cool stars, intersteller dust and other phenomena in the ultraviolet spectral region.



Global Mapper—A pair of new high-resolution TV cameras to be flown on NASA's Landsat-C are checked out by RCA program manager Bert Soltoff. The cameras, designed and built for NASA's Goddard center by RCA Astro-Electronics, will take pictures of the Earth in 129½ by 129½ square kilometers. Thus, high-quality maps can be produced of remote regions of the Earth never before mapped in precise detail.

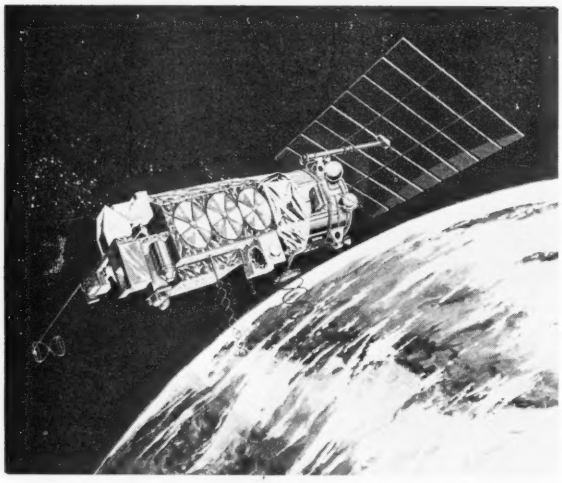
obtained by ISEE-1 and ISEE-2. ISEE-1, developed by NASA, and ISEE-2, developed by ESA, were launched in tandem on a Delta, Oct. 22, 1977.

NATO-III-C, a North Atlantic Treaty Organization communications satellite, is on the launch schedule for September. Launch will be on a Delta from Cape Canaveral.

Telesat-D, a domestic communication satellite that will be renamed Anik-4 once in orbit, will be launched for Telesat Canada in November. Launch will be on a Delta from Cape Canaveral.

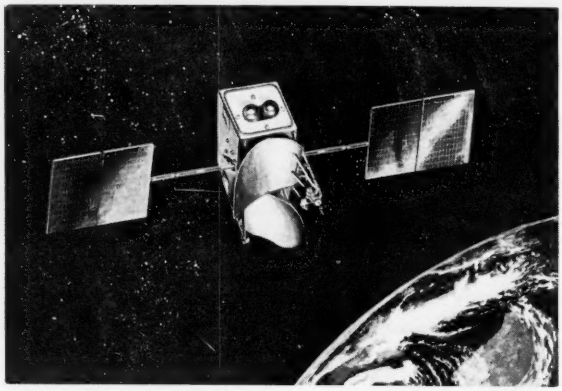
High Energy Astronomy Observatory-B is scheduled for launch on an Atlas Centaur during October. HEAO-B will maneuver and point for long periods of time at selected celestial X-ray sources mapped earlier by HEAO-A and other X-ray spacecraft. HEAO-1 was launched Aug. 12, 1977. Another FLTSATCOM spacecraft is scheduled for launch during November, also on an Atlas Centaur.

Scheduled for launch on Atlas-F launch vehicles from Vandenberg are Seasat-1, a NASA polar orbiting spacecraft for global monitoring of the oceans and ocean phenomena, in May; TIROS-N, a NASA polar-orbiting experimental weather satellite, also in May; and NOAA-A, a polar-orbiting weather satellite for NOAA later in the year.



Weather Watcher—How an artist sees the RCA-built Tiros-N, a new third generation meteorological satellite. Scheduled for launch by NASA in 1978, the advanced, polar-orbiting satellite will carry a broad array of sophisticated sensors to provide greatly improved data for use in world-wide weather forecasting and environmental observation. Tiros-N is being developed by RCA Astro-Electronics, Princeton, N.J., for NOAA.

A possible Delta call-up launch is on the 1978 schedule, if required to replace a presently operational Environmental Satellite-C (GOES-C), would be launched from Cape Canaveral. In addition, Nimbus-G, a NASA research satellite for testing sensors for oceanographic and meteorological monitoring, is planned for launch from Vandenberg in August.



New Canadian Satellite—Telesat-D (Anik-P4), an advanced dual-band domestic communications satellite is one of the spacecraft to be launched in 1978. It will provide a variety of communications services for Canada's 10 provinces and two territories. The high-capacity satellite is designed and built by RCA Astro-Electronics of Princeton, N.J. for Telesat Canada.

HEAO-1 Continues Collecting Astronomical Data

NASA's first Earth-orbiting High Energy Astronomy Observatory in early December completed its first 100 days of operation. The observatory and its experiments continue to function satisfactorily and are producing significant advances in the knowledge of celestial X-ray and gamma-ray sources, according to HEAO project scientists.

HEAO-1, launched Aug. 12, 1977, is the first in a planned series of three large unmanned orbital observatories designed to provide scientists with a capability to study X-rays, gamma rays and cosmic rays emitted by stars and star-like objects throughout the universe. The Marshall Space Flight Center manages the HEAO program, under the direction of Dr. Fred A. Speer.

Based on extrapolation of current results, the number of known X-ray objects can be expected to grow from about 200 to 1,000 or 1,500 by the time the HEAO-1 operation is completed, scientists said.

The useful life of the observatory appears now to be at least 16 to 18 months, and NASA is taking steps to extend the activities of all HEAO participants

beyond the original six-month mission to one of data collecting, with additional operations to be considered later.

To date, 15 previously unknown X-ray sources have been discovered in a limited portion of space, according to preliminary analyses of the data from HEAO-1.

Detailed data have been taken by HEAO-1 which may eventually allow astronomers to make a positive identification of at least two "black holes"—believed to be the final stages in the collapse of dying stars of massive size.

Another result of great interest to astronomers is the discovery of very-low energy (long wavelength) X-rays from the well-studied star, *U. geminorum*.

An especially gratifying result of HEAO-1 observations to date is the manner in which two of the observatory's experiments capabilities are combined to provide the most precise location of X-ray sources ever obtained. Another important early result from HEAO-1 is the collection of information on the mysterious gramma-ray bursts first discovered only a few years ago.

Location of the various phenomena can be obtained only by combining the data from a network of widely spaced satellites. HEAO-1 is now a member of this network along with the Helios satellite, which is now about 100 million miles from the Earth.

NASA Update '77 Program

One of the ways NASA gives the public a first-hand look at its research and development programs and their many benefits is through community involvement programs. NASA's Kennedy Space Center recently organized a large version of this type of NASA program in the Florida Bradenton-Sarasota and St. Petersburg area, which contains a population of nearly two million.

Under the direction of Ray Corey, chief of KSC's educational programs branch, in cooperation with NASA headquarters, the project was named NASA Update '77, and was displayed for nearly a month at each of the two locations.

NASA provided exhibits, speakers, and technical guidance for NASA Update '77, but the program was managed and conducted on a volutary basis by the county school systems, local governments, civic and professional groups, news organizations, and industries from the surrounding areas.

NASA Update '77 provided aerospace science lectures and demonstrations to civic organizations and 75 public and private schools. A highlight in the high schools was the science fiction writing contest. A qualified KSC technical writer conducted workshops in the schools and judged the essays. NASA provided teacher kits for every instructor in the three-county area and library kits were provided to every school and public library.

Several exhibits, including a lunar sample, were displayed at a museum and planetarium, and also at a shopping center where as many as 30,000 people a day viewed them. Astronauts Don Lind and Paul Weitz, attended banquets and participated in various community activities.

Corey said he viewed the operation an outstanding success and considered the community involvement superb. He is planning his next community involvement program for next fall in the Atlanta, Ga. area.

New Aid to Community Relations—A Spacecoast information booth recently was opened and dedicated at the Kennedy Center's visitors center. The four area chambers of commerce sponsor the booth, aimed at attracting some of the 1½ million annual Spaceport visitors to other parts of Brevard County. The booth will be manned on the same hour basis as the visitors center.

A Reproduction of the Space Shuttle in Practice Runs

A homemade Space Shuttle orbiter made from rocket scrap parts and steel beams explored the streets of the Marshall Space Flight Center and stood in for the real orbiter during practice lifts into the tower where the real thing soon will be tested.

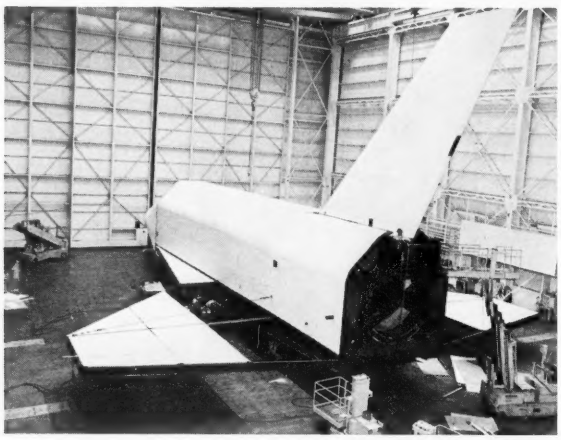
The *Enterprise*, the planelike, manned portion of the Space Shuttle, successfully completed a series of approach and landing tests in California during the past several months.

The next series of tests, to be conducted at Marshall, will check out the ability of the orbiter and the other components of the Space Shuttle to maintain

proper guidance and control under vibration conditions encountered during launch and powered flight.

Before the *Enterprise* arrives, Marshall engineers will use the simulated orbiter to practice many of the tasks they know will have to be done right on the first try when actual testing begins. The simulator will be used to try out the facility that will remove the orbiter from its 747 carrier aircraft. It will be towed along the roadways for the testing of clearances on all sides.

The most dramatic test in the recent series came when engineers at Marshall practiced hoisting the fake orbiter into the 131-meter tall test stand where the *Enterprise* will be mated to the other Space Shuttle components for the first time.



Imitation Orbiter—A simulated Space Shuttle orbiter takes shape in an assembly area at the Marshall center. In size, shape, weight and center of gravity, the imitation closely matches the real orbiter, due to arrive in Alabama in 1978. This homemade version is used to try out the facilities needed to handle various movements and tests of the *Enterprise*.

Japanese Communications Satellite Launched

A Japanese medium capacity communications satellite was launched by NASA on Dec. 14 from the Kennedy Space Center. One of the largest spacecraft ever to be launched by the Delta 2914 vehicle, it is a communications satellite for experimental purposes and is part of a program conducted by the National Space Development Agency of Japan (NASDA). Its mission is to relay communications and television signals among the Japanese Islands.

CS is more than 351 centimeters long and 218 cm in diameter. The satellite weighs approximately 676 kilograms at lift-off and 340 kg once injected into geosynchronous orbit.

The Japanese satellite is equipped with six K-band and two C-band communications transponders for relay of communication and television signals throughout the islands, and is the first one to operate in the 30/20 GHz (K-band).

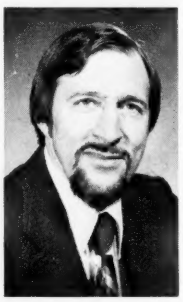
Primarily powered by solar cells which cover the cylindrical main body, the satellite is augmented by a battery for eclipse mode operation. The solar array provides more than 500 watts of electrical power absorbed from the Sun's energy by more than 20,000 solar cells.

Earth sensors aboard the CS are used as a reference for maintaining pointing of the communications antenna. The main body of the satellite spins at 90 r.p.m. and acts as a gyroscope to provide satellite stability. Thrusters, using monopropellant hydrazine, provide attitude and station keeping capability. The satellite is designed to operate for more than three years. It will be used for telephone and television distribution service. Experiments will be conducted to determine its suitability for operational communications systems.

The Delta launch vehicle is managed for NASA's Office of Space Flight by the Goddard Space Flight Center. The expendable launch vehicles division at NASA's Kennedy Space Center is responsible for management of launch operations. NASDA is responsible for the satellite's procurement, launch and initial checkout and for reimbursement to NASA for costs of launch support.

The CS was designed, developed and manufactured by the Mitsubishi Electric Corp. and Ford Aerospace and Communications Corp. Prime contractor for the Delta launch vehicle is McDonnell Douglas Astronautics Co. of Huntington Beach, Calif.

Stofan Named Space Sciences Deputy



Andrew J. Stofan, former director of launch vehicles at the Lewis Research Center, became Deputy Associate Administrator for the Office of Space Sciences at NASA headquarters effective Jan. 8, 1978.

In his new position, Stofan will help direct all NASA's space flight programs concerned with scientific investigations of the solar system through the use of ground-based, airborne, and space methods; scientific experiments to be conducted by man in space; and the development and use of light- and medium-class launch vehicles.

Stofan began his professional career at the Lewis center in 1958 as a research engineer and in 1962 was assigned to the propellant system section of the Centaur project office, becoming head of the section in 1966.

He worked on Centaur programs until 1969 and became project manager of the Titan/Centaur vehicle in 1970. He served in that post, where he was responsible for all activities associated with the design and development of the Titan/Centaur launch vehicle, until he was named director of launch vehicles in 1974.

Under Stofan's direction, the Lewis center launched 10 Atlas/Centaur vehicles carrying a high energy astronomy observatory and numerous commercial global and domestic communications satellites; and six Titan/Centaur vehicles which launched both Viking missions to Mars, both Voyager missions to the outer planets of Jupiter and Saturn, and two Helios U.S.-German satellites to investigate the Sun.

Stofan received Group Achievement Awards for the Titan/Centaur Project team and the Helios team in 1975. He also received the NASA Exceptional Service Medal in 1975.

A native of Cleveland, Stofan received his bachelor of arts degree from Hiram College, Hiram, Ohio in 1958. In the same year, he won a bachelor of science degree in mechanical engineering from Carnegie Mellon University in Pittsburgh.

He also has done graduate work at Case-Western Reserve in Cleveland.

Truszynski Retires from NASA

Gerald M. Truszynski, NASA's Associate Administrator for Space Tracking and Data Systems, retired in late December after 33 years of government service with NASA and its parent organization, the National Advisory Committee for Aeronautics (NACA).

Truszynski's career with NACA began in 1944 when he joined the Langley Aeronautical Laboratory in Hampton, Va. as an engineer in instrument research and development. Three years later, he transferred to the NACA station at Edwards, Calif., as instrument project engineer on the rocket-powered X-1, the first airplane to breach the speed of sound.

In 1954, Truszynski became chief of the instrumentation division at Edwards, heading development and operation of instrumentation and tracking systems for the national research airplane program—including a series of jet and rocket-powered aircraft such as the X-1, X-2, D-588 and X-15, which were pioneers in supersonic and hypersonic flight.

Truszynski came to NASA headquarters in 1960 and was named deputy in the office of tracking and data acquisition in 1961, becoming Associate Administrator in 1968. As such, he was responsible for the planning, development and operation of global tracking networks, facilities and systems for communication, and data acquisition and processing for all NASA space flight programs.

In 1969, Truszynski twice received NASA's highest award, the Distinguished Service Medal, for support of Apollo manned flights to lunar orbit (Apollo 8) and man's first landing on the Moon (Apollo 11).

He is a member of Tau Beta Pi. In June 1973, the American Astronautical Society elected Truszynski a Fellow for his significant contributions to aeronautics.

Norman Pozinski is serving as acting Associate Administrator.

Pioneer 11 to Fly Near Rings of Saturn

NASA's Pioneer 11 will fly just outside the rings of Saturn during the first encounter with the giant planet in 1979. The spacecraft will pass 30,000 kilometers from the edge of the outer ring and will swing in, under the ring plane, to a distance of 25,000 km from the surface of Saturn.

The decision to fly outside the rings rather than to pass inside them was made by Dr. Noel W. Hinners, NASA Associate Administrator for Space Science, and A. Thomas Young, Director of Planetary Programs. It was based primarily on the desire of NASA to use Pioneer as a pathfinder for two Voyager spacecraft now headed toward encounters with Saturn in 1980 and 1981.

Voyager 1 is scheduled to approach Saturn in November 1980 after flying past Jupiter, followed by Voyager 2 in August 1981. If all goes well at Saturn, the option is available for Voyager 2 to head for an encounter with the planet Uranus in 1986.

Pioneer's outside pass will cross the ring plane at about the same distance as the trajectory that would use Saturn's gravity to hurl Voyager 2 towards Uranus.

Questions surrounding the potentially harmful effects of Saturn's rings on Pioneer—considered even more dangerous inside than outside the rings—are of concern to scientific managers of the mission, even though the crossing (at 30,000 km) is far from actual contact with the rings. If Pioneer does not survive the rings at Saturn, NASA almost certainly will have to

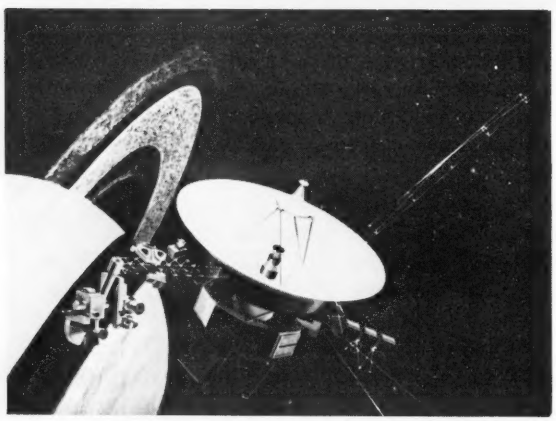
reassess its plan to continue to Uranus with Voyager 2, according to agency officials.

Chances of surviving the outside pass are estimated to be much greater than those of surviving an inside pass ,which would have brought Pioneer as close as 6,000 km to the planet.

"Alternatively, a successful Pioneer will greatly increase our willingness to commit Voyager 2 to the Uranus option, even if Voyager 1 has perhaps not achieved all of its objectives at Saturn," Young said. "Thus either survival or non-survival of Pioneer on the outside trajectory can have an important influence on Voyager plans, and therefore on achieving maximum science return from all three spacecraft."

The Pioneer was targeted for Saturn after providing man with his second closeup look at Jupiter in December 1974. A sister spacecraft, Pioneer 10, flew past Jupiter for the first time in December 1973. The 1979 Pioneer flyby will mark the first encounter with Saturn.

The rings of Saturn are an extraordinary phenomenon familiar to nearly every amateur astronomer. They were discovered by Galileo in his primitive telescope, but first recognized as rings by Christian Huygens in 1656. Until the recent discovery of the rings of Uranus, Saturn was believed to be the only ringed planet in the solar system. The four rings (the fourth was discovered in 1969) range outward some 137,000 km from the center of Saturn. The widths of the rings range from 25,000 km for the innermost to 16,000 km for the outermost ring.



Measuring Saturn's Rings—This painting shows how Voyager spacecraft will fly behind the rings of Saturn and use cameras and radios to measure how sunlight is affected as it shines between ring particles. Scientists know little about the components of the rings, but believe they may be composed of ice crystals and rock. The three known rings of Saturn are shown, as well as the gap between the middle and outer rings, called Cassini's Division.

The diameter of the rings is very thin, with estimates ranging from a few centimeters to 16 km. When viewed edge-on from Earth, the rings are practically invisible. When viewed at an angle, they are a brilliant sight.

In 1970, astronomers determined that the ring particles were made of ordinary water ice. Radar measurements made in 1973 indicate that the rings contain large chunks of solid material in orbit like a swarm of tiny moons, but scientists still don't know whether the smaller particles are mostly snowball-sized or still smaller, perhaps no larger than a grain of sand.

The origin of Saturn's rings is not truly known. Scientists speculate that a large planet-like mass once wandered too close to Saturn and was torn apart by the planet's gravitational forces. The chunks that form the encircling rings may be the debris of the shattered body.

Saturn itself is about 120,000 km in diameter. Its mass is calculated to be 95 times that of Earth. Yet it is believed to be a gaseous body with a density less than water. Saturn's atmosphere is mostly hydrogen. Titan, one of 10 moons circling Saturn, is the largest satellite of any planet. It is also the only known moon with an appreciable atmosphere.

The Beginning: Serene Process or Chaotic Bang?

Was the explosion that marked the beginning of our universe violent and chaotic—a "big bang?" Many scientists think so. But measurements made recently by a team of researchers using a high flying NASA aircraft suggest that our cosmos may have started more serenely—with a powerful but tightly controlled and completely uniform expansion, more like the blossoming of a plant or a flower.

Using ultrasensitive radio equipment aboard an Ames Research Center U-2 jet, the research team measured the cosmic microwave background—the radiation left over from the "big bang," the initial, universe-forming event—and surmised that Earth's birth was not explosive but almost serene, with matter and energy uniformly distributed, expanding at an equal rate in all directions.

The findings were made by Drs. Richard Muller and George Smoot, and graduate student Marc Gorenstein of the Lawrence Berkeley Laboratory and the University of California at Berkeley, who also designed and operated the radio equipment.

By measuring the movements of the Earth against the "glow" left from the fireball in which the

universe was born, they also found that the Milky Way galaxy, together with the solar system and Earth, appear to be hurtling through space at more than one million miles per hour towards the constellation Hydra.

"The radiation left over from the universe-forming event about 15 billion years ago is so uniform that it provides a universal reference for measuring this motion," said Gorenstein.

"Another major surprise is that the U-2 measurements seem to show that there is no rotation of the universe," said Smoot. "This is surprising because we can see that everything within the universe is rotating—planets, stars, and galaxies. If there is rotation, it has to be less than one hundred millionth of a rotation in the last billion years."

"Our measurements give a picture of an extremely smooth process," the researchers said. "The big bang, the most cataclysmic event we can imagine, on closer inspection appears finely orchestrated. Either conditions before the beginning were very regular, or processes we don't yet know about worked to make the universe extremely uniform."

The uniformity was greater than one part in 1,000 for matter, one part in 3,000 for energy, and one part in 10,000 for expansion.

According to the currently accepted big bang philosophy, the universe began as a hot, incredibly dense mass containing all the matter in the universe. At a certain "initial" instant, the primeval fireball exploded in the most violent and immense catacylsm imaginable.

As the universe continued its expansion and the temperature dropped, protons and neutrons began to fuse into nuclei and remained fused for increasingly longer periods of time. At first hydrogen, then deuterium and later helium evolved. After millions of years, the material had cooled sufficiently to condense into galaxies and within the galaxies into stars and planets. As a consequence of the colossal explosion, the galaxies have continued to separate from each other, and thus form the expanding universe we observe. Those galaxies farthest from Earth appear to be traveling the fastest.

"The large-scale regularity we have found in the expansion of the universe makes the million-mile-an-hour random local motion we have detected for the Earth and our galaxy all the more surprising," Smoot says.

The U-2 plane, at an altitude of 19,800 meters, flies above 90 percent of the Earth's atmosphere where these sensitive experiments must be conducted. In charge of the flights for the Ames center was James Cherbonneauz, U-2 project manager. When it is not investigating the cosmos, the U-2 jet is used for agricultural and Earth resources photography.

Dr. Muller explains that the instruments carried aloft by U-2 aircraft seek out the radiation just reaching Earth from the remnants of creation farthest away from Earth. "Their light is only now reaching us," Muller said, "just as our light is just reaching them."

The project was funded by the Department of Energy and NASA. Measurements so far have covered almost the entire sky over the northern hemisphere or half the celestial sphere.

NASA Grants Numerous Contracts for Solar Cell Production

Contracts totaling more than $4 million have been negotiated with nine companies for development of low-cost, automated fabrication processes for solar cells. Thirty percent of the contracts are with small businesses.

Contractors will develop a variety of processes and techniques that subsequently may be integrated into an automated assembly line for mass production of solar cells and modules. These efforts are part of the low-cost silicon solar array project, managed for the Department of Energy by NASA's Jet Propulsion Laboratory.

Selected companies for 12-month contracts are:

Lockheed Missiles & Space Co., Inc. Sunnyvale, Calif.	$213,163
M.B. Associates, San Ramon, Calif.*	$230,000
Motorola, Inc. Phoenix, Ariz.	$433,870
RCA, Princeton, N.J.	$846,900
Sensor Technology, Chatsworth, Calif.*	$395,000
Solarex Corp., Rockville, Md.*	$392,000
Spectrolab, Inc., Sylmar, Calif.	$706,000
Texas Instruments, Dallas, Texas	$537,460
Westinghouse, Pittsburgh, Pa.	$426,000
Total	$4,180,393

DOE objectives are to reduce the costs of solar cell arrays to make them competitive with other sources of electric power. Present average costs, as measured by government purchases in relatively large quantities, are about $11 per peak watt. DOE goals are to reduce these costs to $2 per peak watt in 1982 and to 50 cents in 1986.

*Small businesses

Cleveland Clinic and NASA Center Join in Cancer Study

Cancer researchers have joined with space technologists at NASA's Lewis Research Center. The Cleveland Clinic Foundation and the Lewis center recently announced an agreement between the two institutions which states that Lewis's 50-million-volt cyclotron will be used in clinical trials of neutron therapy used to treat tumors. The first patient has received treatment.

Dr. William S. Kiser, chairman of the clinic's board of governors, said the program will be funded for three years by a $519,000 grant from the National Cancer Institute. The clinic paid the $200,000 cost for necessary modifications of the cyclotron facilities to make them suitable for patient care.

Patients who will receive the treatments at the campus-like NASA complex, will be selected by physicians throughout the Great Lakes area in coordination with the staff of the radiation therapy department of the Cleveland clinic. Clinic physicians will administer the treatments in coordination with each patient's referring physician. Their activities are integrated in the program of the Cancer Center of Northeast Ohio, Inc., of which the Cleveland clinic is a member.

Cleveland is the fourth area of the country where such trials are underway. Other "fast neutron" treatment centers are at M. D. Anderson Hospital and Tumor Institute, Houston, Texas; U. S. Naval Research Laboratory, Washington, D.C., and Fermi National Accelerator Laboratory, Batavia, Illinois.

The Cleveland Clinic Foundation is one of the world's largest privately-funded medical centers. Its group practice staff of 300 physicians and scientists provides specialty care for nearly 3,000 patents each day. The institution has a 1,008-bed hospital, extensive outpatient facilities, a division of research and an institute for postgraduate and continuing medical education that serves approximately 2,500 physicians annually.

"Neutron therapy has shown beneficial results in the treatment of certain tumors, but it is still largely an investigative technique. We view the program as a challenging opportunity to evaluate this relatively new approach to radiation treatment," said Dr. Antonio R. Antunez, head of radiation therapy for the Cleveland clinic and medical director of the cyclotron program.

Of NASA's involvement, Dr. Bernard Lubarsky, acting director of Lewis, said: "It is always gratifying to be able to transfer space technology to the health field, and we at Lewis are particularly pleased in this case to be able to contribute to new studies of a public health problem of worldwide concern. Whatever progress we make in this team approach will be well worth the effort."

Basic steps in adapting the Lewis cyclotron to its new role included rerouting of the neutron beam, calibrating the instrument to provide exact prescribed dosage levels, and construction of a properly shielded patient treatment room, together with associated facilities. The Lewis facility will allow for treatment of the patient in either a vertical or horizontal position. Doctors believe the vertical neutron beam treatment, a unique aspect, wil make it possible to more readily treat tumors located in the thoracic or pelvic regions.

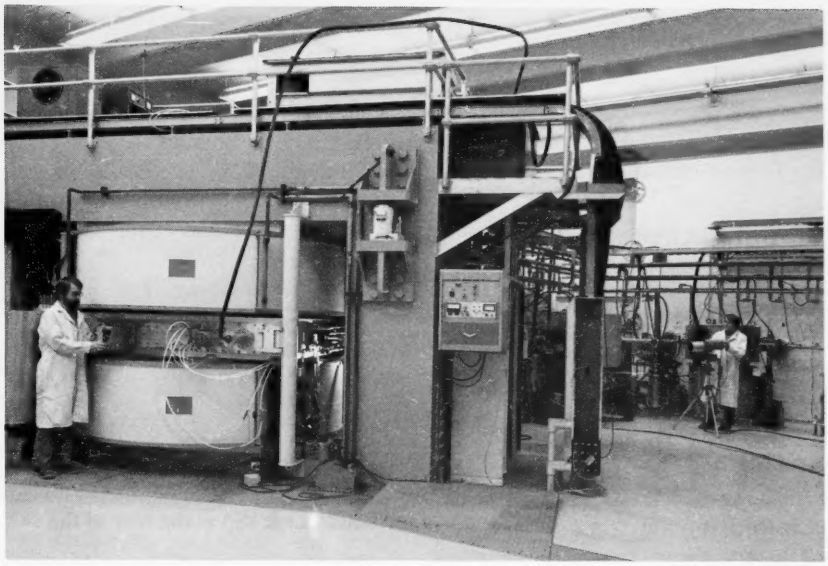
Why is neutron therapy used only in the case of carefully selected patients, and how does it differ from conventional radiation therapy?

"To be a suitable candidate for neutron therapy, a patient must have a tumor that has not spread and that cannot be effectively treated by conventional procedures such as surgery, cobalt, x-ray or chemotherapy," said Dr. Antunez.

In the "fast neutron" procedure at Lewis, the physician will determine the amount of radiation the patient is to receive and enter this and other information on a keyboard terminal connected to a computer located in the cyclotron control room. The patient's exposure will be continuously monitored and automatically terminated by the computer when the proper dosage has been given. Independent circuitry will also monitor the exposure so that dosage levels can be maintained in the unlikely event of computer failure during treatment.

Early attempts at a neutron therapy took place before World War II in Berkeley, Calif., but because wartime demands limited use of available cyclotrons to atomic weapons research, clinical trials were not resumed until 1968 in England. In 1972, encouraging results from neutron therapy experimentation at Hammersmith Hospital in London spawned similar programs in this country at Houston and Washington, D.C.

The earliest cyclotron at Lewis dates from 1956. Its principal use then was to perform radiation studies related to nuclear propulsion systems for aircraft and spacecraft. In 1972 this cyclotron was modified to produce the present computer-operated system. In addition to being used in nuclear propulsion studies at the center in recent years, the cyclotron also has been involved in the production of radioisotopes for diagnosis of heart disease.



The Lewis Center Cyclotron—The huge 50-million-volt cyclotron that is to be used in clinical trials of tumor treatments. Patients receiving initial trial treatment will be from the Great Lakes area.

Measuring Radiation—A Lewis center scientist, in a rehearsal of the administration of neutron therapy on cancer-stricken people. He is operating the control apparatus that gives a precisely measured amount of radiation to the patient in a separate treatment room.

Solar Heating at Wallops

Since June 1977, five Chamberlain liquid flat-plate solar collectors have been heating domestic water for a wing of one of the Wallops Flight Center buildings. On a clear sunny day, the roof-mounted, 32-meter solar array is capable of heating 121 liters of water per hour from 10 to 45 degrees C.

An .05 hp pump circulates an antifreeze solution, which picks up heat from the solar panels and rejects it through a heat exchanger to a 871-liter, hot-water storage tank. The storage tank supplies domestic hot water to the building via the original hot-water system. When the sun is not cooperative, the conventional system assures an adequate supply of hot water.

The system was designed by Mitch Brown and Bill Phillips of the technical support directorate, facilities engineering branch, engineering and planning section, and installed by Wallops personnel.

New Chief Scientist for Space Processing at Marshall

Dr. Robert J. Naumann, chief of the space processing division of space sciences laboratory at NASA's Marshall Space Flight Center, has been designated chief scientist for space processing applications.

As chief scientist, Naumann's duties will involve the space processing applications rocket program, space shuttle orbital flight test materials experiments in space, and materials processing on the Shuttle. These are in addition to his regular duties at Marshall.

Dr. W. R. Lucas, Marshall center director, said in his appointment announcement that Naumann will call upon scientific expertise as required to "evaluate proposals and reports, review experiments readiness, plan and implement research and development, and hold symposia in support of the space processing applications task team manager."

Dr. Baumann, a native of Birmingham, Ala. received his doctorate in physics from the University of Alabama.

KSC Bracing for Space Shuttle Flights

Next fall, more than three years since the last Saturn roared skyward from launch complex 39, the characteristic hustle and bustle of manned space flight once again will dominate the scene at the Kennedy Space Center.

It will begin next October when orbiter 102, fresh from the assembly line in California, soars piggyback into KSC atop its 747 carrier aircraft. The stubby delta-winged craft—designed to rumble into orbit like a rocket, maneuver beyond the atmosphere like a spaceship and return to earth and land on a runway like an airplane—will be the first of its kind to test the rigors of celestial flight.

In November and December, the remainder of the Space Shuttle flight kit—orbiter main engines, external tank and solid rocket booster motors (SRBs)—will arrive at KSC. Along with the orbiter, they will enter the test, assembly and checkout pipeline that will culminate in a scheduled launch from complex 39 in March of the following year.

After completion of six development flights, including four landings at the Dryden Space Flight Center, the Space Shuttle will commence operational missions from the Kennedy center in May 1980. KSC was selected in 1972 as the primary launch and landing site for Shuttle operations.

Construction of new facilities and modifications to existing ones are proceeding on schedule at KSC to support the Shuttle's debut.

The landing facility, where the Shuttle orbiter will land on its return to Earth, was completed last August. Supporting facilities such as the mate-demate device, to offload the orbiter from its 747 carrier aircraft, and the microwave landing system, to guide the orbiter to an automatic landing, will be completed in April 1978. Meteorological sites to support landing operations were completed in November 1977.

One of the world's longest concrete runways, the orbiter landing facility is 4.5 kilometers long, 91 meters wide and has a 300-m safety overrun at each end. The facility is located northwest of the vehicle assembly building (VAB).

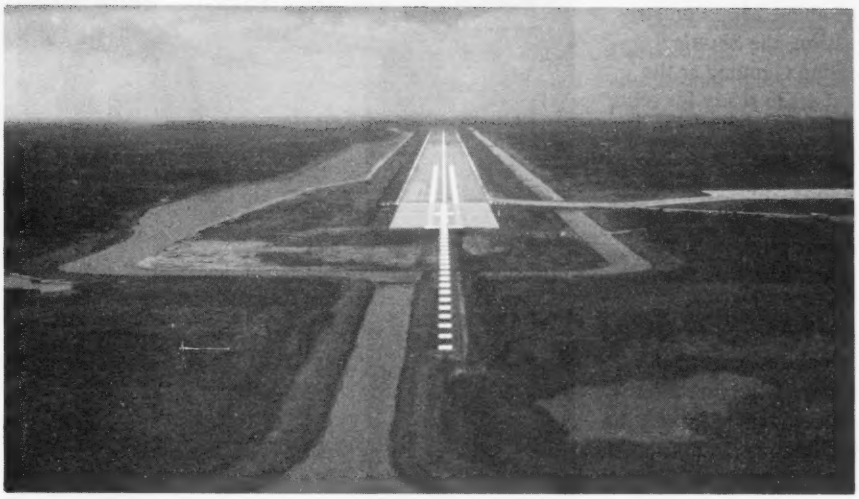
The orbiter processing facility, located adjacent to the VAB and connected to the landing facility by a 3.2-km towway, is essentially completed except for the installation of some remaining stands and systems expected to be in place by April. The two-bay structure will serve as an aircraft "hangar." It is here, in a "clean room" environment, that ordnance and residual fuels will be rendered safe, flight and landing systems will be refurbished and payloads will be removed and installed.

The orbiter landing facility and the orbiter processing facility are the only new facilities required to support Shuttle operations at KSC. The remaining Shuttle preparations consist of modifications to existing facilities originally designed and built to support the Apollo lunar landing missions.

Only one structure on Cape Canaveral Air Force Station will be modified to support Shuttle operations. Hangar AF will be transformed into a solid rocket booster recovery and disassembly facility. It will serve as a receiving and disassembly site for the reusable SRBs after their retrieval from the ocean following Shuttle launches. Modifications, which began in January, will be completed in the last quarter of next year, and will include a barge slip at the rear of the building.

The eventual cost of construction, modification work and ground support equipment to support Space Shuttle operations at the Kennedy Space Center will be about $700-800 million.

Preparing for Shuttle Work—Looking much like a giant erector set, new construction shown at the Kennedy center is underway for the payload changeout room at launch complex 39, pad A. Completion date is Sept. 1, 1977. The facility will provide the capability of loading the orbiter vertically and make installation or removal of payloads to and from the Shuttle possible at the launch pad.



Shuttle's Runway—The Space Shuttle's orbiter landing facility at the Kennedy Space Center, shown from an altitude of 300 meters. It is built in a south to north direction.

Orbiter Processing Facility—An artist's view of the almost completed processing facility for the Space Shuttle orbiter, located adjacent to the VAB and connected to the landing facility, at the Kennedy center.

Six American, Four Europeans Compete for Jobs on Spacelab

Six American scientists and four Europeans are finalists in the competition for one of two payload specialist positions aboard the first flight of Spacelab, the space laboratory to be flown in NASA's Space Shuttle in 1980. One American and one European eventually will be selected to fly on the first Spacelab mission and operate the scientific instruments.

The Europeans were chosen from a group of finalists by the European Space Agency, which is jointly undertaking the flight with NASA. Each agency is providing scientific instruments and personnel. Spacelab itself is being built by ESA, and NASA has operational responsibility for the launch and conduct of the mission.

Five of the candidates will undergo extensive training following a final selection in early spring. Of the five payload specialists trained, two will go into space, while the other three will perform support and advisory roles in the control center on Earth.

Payload specialists, who are employed by the payload sponsoring agency, differ from NASA's permanent astronaut pilots and mission specialists in that they are selected and trained specifically for a particular mission. During the mission, the payload specialists work in such a way as to provide time and opportunity for the scientists responsible for the mission investigations to concentrate on carrying out their responsibilities. Flying and maintaining the Space Shuttle vehicles rest with the permanent astronaut crew.

The first Spacelab will be launched aboard the Space Shuttle from NASA's Kennedy Space Center and will

orbit the Earth at an altitude of about 250 kilometers. At the end of the seven-day mission, the Shuttle orbiter will return for a runway-type landing at the Kennedy center, be serviced and made ready for other missions.

On the Spacelab 1 mission, investigations will be conducted in stratospheric and upper atmospheric physics, materials processing, space plasma physics, biology, medicine, astronomy, solar physics, Earth observations and in technology areas such as thermodynamics and lubrication.

NASA's Marshall Space Flight Center will direct the payload specialists' training activities as part of its overall management responsibility for the first three Spacelab missions. ESA's Spacelab payload integration and coordination organization will manage the training activities in Europe.

The names, biographical data and current duty station or place of employment of the 10 candidates recently named are:

Craig L. Fischer, MD, born Feb. 17, 1937, resides at Indian Wells, Calif., employed at the Palm Desert Medical Group, Inc., Palm Desert, Calif.

Michael L. Lampton, Ph.D (space physicist), born March 1, 1941, resides at Berkeley, Calif., employed at the University of California at Berkeley.

Byron K. Lichtenberg, Ph.D candidate (biomedical engineer), born Feb. 19, 1948, resides at Natick, Mass., employed at Massachusetts Institute of Technology, Cambridge, Mass.

Robert T. Menzies, Ph.D (physicist), born March 31, 1943, resides at Pasadena, Calif., employed at NASA's Jet Propulsion Laboratory.

Richard J. Terrile, Ph.D (planetary scientist), born March 22, 1951, resides at Pasadena, Calif., employed at the California Institute of Technology, Pasadena, Calif.

Ann F. Whitaker, physicist, born March 17, 1939, resides at Huntsville, Ala., employed at NASA's Marshall Space Flight Center.

Franco Malerba, 31, Italian; engineer; Digital Equipment Corp., Milan, Italy.

Ulf Merbold, 36, German; scientist, Max-Planck GmbH, Stuttgart, West Germany.

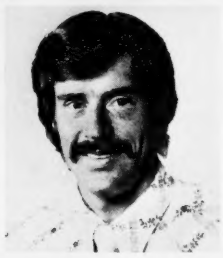
Claude Nicolleier, 33, Swiss; scientist and pilot, ESTEC, Noordwijk, Netherlands.

Wubbo Ockles, 31, Dutch; physicist, Groenigen University, Groenigen, Netherlands.

Fischer

Lampton

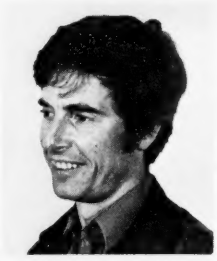
Lichtenberg



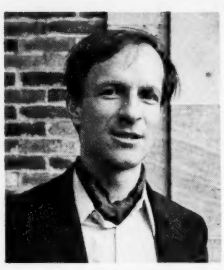
Menzies

Whitaker

Malerba



Merbold



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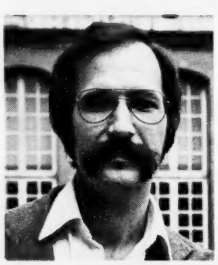


Ockels

Did You Know?

Voyager 1 finally caught up with, and passed, its sister ship, Voyager 2, at about 127 million kilometers from Earth, in late December enroute to the planet Jupiter. The speedier Voyager 1 will be four months ahead of Voyager 2 when it arrives at Jupiter, the first major event in the mission, now set for December 1978.

Pioneer 10 in December was more than 2 billion kilometers from Earth. The Deep Space Network continues to maintain communication with the spacecraft. If improvements currently planned are put into use, the DSN could continue to return scientific data from the spacecraft until 1983.

NASA has received a check for $100,000 from RCA American Communications, Inc., to reserve space on a Space Shuttle flight in the late 1980's or in early 1981. Another early reservation has been made by Gilbert Moore's family, residents of Utah. Moore's son's experiment will be about lizards and how they regenerate their tails—he will try to ascertain whether weightlessness affects regeneration of tissue. The experiment, called a "getaway special" cost the Moore family $10,000.

Two runway surface experts were sent by NASA to the Funchal Airport in Madiera at the request of Portuguese Civil Aviation Authorities to consult on runways. The Madiera airport was the site of a tragic skid crash that killed 129 persons last November. The National Transportation Safety Board did a preliminary accident investigation and recommended NASA expert follow-up, which was approved by the State Department.

California's Gov. Jerry Brown recently signed the first state-NASA agreement on application of space technology to state problems. The "joint memorandum of understanding," the first of its kind between NASA and a state, "sets forth basic principles and guidelines under which both parties will work together on projects of mutual interest." Those projects include use of satellites for monitoring such environmental activities as snowpack for reservoir management and water allocation, as well as potential application of advanced space technology to earthquake prediction, monitoring of tanker traffic and oil spills. Other energy-related activities also will be considered.

A new publication, "American Experiments on Cosmos 782" (NF-77), is a black and white, eight-page educational publication issued by NASA's Office of Public Affairs. The Soviet Cosmos 782, launched in 1975, carried four biological experiments developed by NASA. Scientific findings of the investigators and projects for students are featured. NF-77 is for sale by the U.S. Government Printing Office for 60 cents a copy.

Contractor News

The Klate Holt Co. of Hampton, Va., has been selected for negotiation leading to the award of a contract to provide facility and equipment maintenance support services to NASA's Langley center. The contract's estimated value over a period of three years is $13 million. There are also two one-year unpriced option periods, to be negotiated during the third year of the contract.

Rockwell International Corp. has signed a supplemental agreement to its cost-plus-award-fee contract with the NASA Johnson center covering three subcontracts. Covered are multiplexer interface adapters, inertial measurement units, and thermal circuit breakers. The addition to the Rockwell contract for the Space Shuttle orbiter is valued at about $4.6 million, bringing the estimated total contract value to $3.27 billion.

International Business Machines Corp. of Gaithersburg, Md. has won a contract from NASA's Johnson center for maintenance of Space Shuttle orbiter data processing hardware. The cost-plus-award-fee contract is valued at about $2 million. IBM will furnish people, equipment, materials, facilities, services and management for maintaining IBM-built orbiter equipment for data processing.

Rockwell International Corp. signed a supplemental agreement to the cost-plus-award-fee Space Shuttle orbiter contract with the Johnson center. The agreement covers 12 previously authorized changes and proposals, including Government-supplied equipment, overhaul and repair, spares, hardware for component testing, and special studies. The supplement adds $3.4 million to the orbiter contract.

A contract with an estimated value of $4.1 million is being negotiated by NASA's Goddard center with the **General Electric/Management and Technical Services Co.** of Valley Forge, Pa. The contract is for sounding rocket launches into the upper atmosphere. General Electric will be responsible for off-site payload design, fabrication and testing, field support at various launch sites, plus the acquisition of post-launch data.

Launches are expected to begin in 1978 and will be conducted from launch sites in New Mexico, and Churchill (Manitoba, Canada).

Honeywell, Inc., Avionics Div. of St. Petersburg, Fla. has signed a $2.4 million contract with NASA's Lewis center to provide management and engineering support for the Centaur inertial guidance program. The cost-plus-award-fee contract will run for a year beginning last Jan. 1. The work will be performed at the contractor's plant at St. Petersburg and at the Kennedy center.

The Rockwell International Corp. has signed a $2.5 million supplemental agreement with NASA's Johnson center covering 10 design changes and additions to the Space Shuttle orbiter.

Radio Corp. of America, Astro-Electronics Div., Princeton, N.J., has been selected by NASA for award of a firm fixed-price contract for the closed circuit television system in support of the Space Shuttle program. The contract—running January 1978 through June 1982—is worth about $10.5 million, including options. It covers the design, development, qualification, production and delivery of the TV systems for training, certification and flight. It provides for the hardware for the first orbital test vehicle design, development, test and evaluation with firm options for subsequent acquisition of TV equipment for added Space Shuttle orbiters and remote manipulator systems.

The Mercury firm of Tustin, Calif. has been selected for negotiation leading to the award of a contract to provide support services for steam and compressed air facilities at NASA's Langley center. The contract, which covers three years, beginning in January 1978, has an estimated value of about $2.4 million.

Inventions and Contributions Board Monetary Awards

The Inventions and Contributions Board has recommended that monetary awards be granted to the NASA employees identified on the attached list for scientific and technical contributions to space and activities. The recommendations were approved by the Administrator and awards have been made.

Innovator(s)	Title of Invention and Contribution
AMES RESEARCH CENTER	
Ronald J. Hruby ..... Robert L. Wilson	Capacitive Shaft Encoder
Gilbert T. Parra	Angle Detector
John Dimeff	Automatic Flow Control & Automatic Shutoff for Intravenous Feeders
GODDARD SPACE FLIGHT CENTER	
James R. Fischer	Cubic Interleaver
Stephen H. Rice ..... Charles M. Fleetwood, Jr. Rodney S. Spencer	Method of Treating the Surface of a Glass Member
David K. Studenick	Fluid Sampling Device
John J. Deluca ..... Wayne E. Hughes	Hydrogen Fueled Rotary Engine
James W. O'Connor	Large Precise Glass Detector Frames
HUGH L. DRYDEN FLIGHT RESEARCH CENTER	
Shu W. Gee	Terminal Guidance System
JOHN F. KENNEDY SPACE CENTER	
Charles H. Bell	Fiber Optic Multiplex Optical Transmission System
R. J. Wojtasinski ..... James H. Jones ..... Raymond V. Lisle	Lightning Current Measuring System
Larry D. Holley	Microcomputerized Electric Field Meter Diagnostic and Calibration System
Larry D. Holley	Digital Automatic Gain Amplifier
JET PROPULSION LABORATORY	
Mahlon F. Easterling ...	Time Synchronization System Utilizing Moon Reflected Coded Signals
Dr. Robert A. Rhein ... John D. Ingham	Curable Liquid Hydrocarbon Propolymers Containing Hydroxyl Groups and Process for Producing Same
Martin H. Leipold	Method of Controlling Defect Orientation in Silicon Crystal Ribbon Growth
JOHNSON SPACE FLIGHT CENTER	
Frederick S. Dawn ..... Dale G. Sauers	Lightweight Electrically-Powered Flexible Thermal Laminate
LANGLEY RESEARCH CENTER	
Robert A. Jones	Auxiliary Power System For Actively Cooled Aircraft
Vernon L. Alley, Jr. .... Austin D. McHatton....	Nozzle Extraction Process and Handlemeter For Measuring Handle
Chase P. Hearn ..... Curtis L. Shriver	Multichannel Logarithmic RF Level Detector

William J. Debnam, Jr.
Maxwell F. McNear
Roger K. Crouch
Roger A. Breckenridge
— Vapor Phase Growth of Groups III-V Compounds by Hydrogen Chloride Transport of the Elements

LEWIS RESEARCH CENTER

Denis J. Connolly — Traveling Wave Tube Circuit

Glen E. McDonald — Selective Coating For Solar Panels

Warren H. Phillipp
Stanley J. Marsik
Charles E. May
— Process for Making Anhydrous Metal Halides

Edward F. Baehr — Corneal Seal Device

Joseph R. Stephens
Charles A. Barrett
— Reduced Chromium Stainless Steel Alloys

BOEING COMPANY

Frank D. Neuman
Gottfried O. Friebel
Armand Sigalla
— Aircraft Design Concept

FEDERAL ELECTRIC CORPORATION

James O. Ward — Digital Automatic Gain Amplifier

Jerry W. Mason — Microcomputerized Electric Field Meter Diagnostic and Calibration System

GENERAL ELECTRIC COMPANY

Richard Ravenhall — Platform For A Swing Root Turbomachinery Blade

Arthur P. Adamson — Gas Turbine Engine With Recirculating Bleed

Paul A. Domas
William N. Barack
Stephen W. Beckman
Charles H. Gay, Jr.
— Redundant Disc

James W. Brantley
Thomas P. Irwin
— Leading Edge Protection For Composite Blades

Richard N. Griffin
Louis R. McCreight
— Conducting Flow Electrophoresis in the Substantial Absence of Gravity

Louis R. McCreight — Electrophoretic Sample Insertion

HOWARD UNIVERSITY

David R. Fischell
Jeffrey Mazique
— A Cervix-to-Rectum Measuring Device In A Radiation Applicator

LOCKHEED AIRCRAFT CORPORATION

Kenneth Vorhaben
Phillip C. Lipoma
— Method and System for Producing Chroma Signals

NATIONAL RESEARCH COUNCIL

Ramesh C. Tyagi — Vapor Phase Growth of Groups III-V Compounds by Hydrogen Chloride Transport of the Elements

NATIONAL SCIENCE FOUNDATION

Ting L. Chu — Low-Cost Substrates For Polycrystalline Solar Cells

OAKLAND UNIVERSITY

Richard E. Haskell — An Optical Process for Producing Clarification Maps from Multispectral Data

ROCKWELL INTERNATIONAL

Phillip J. Stocker
Harris L. Marcus
— Laser Extensometer

George E. Anderson
Donald M. Fell
Jerry S. Tesinsky
— Flexible Pile Thermal Barrier Seal

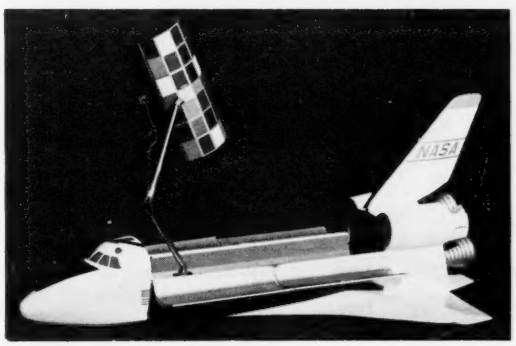
UNITED TECHNOLOGIES INCORPORATED

Frank H. Bonisch — Automatically Lockable Axially Extensible Strut

WESTINGHOUSE ELECTRIC CORPORATION

Earl S. Schlegel — Improved Gate-Assisted Thyristor and Method Including Cathode Shunts

James Vine — Magnifying Image Intensifier

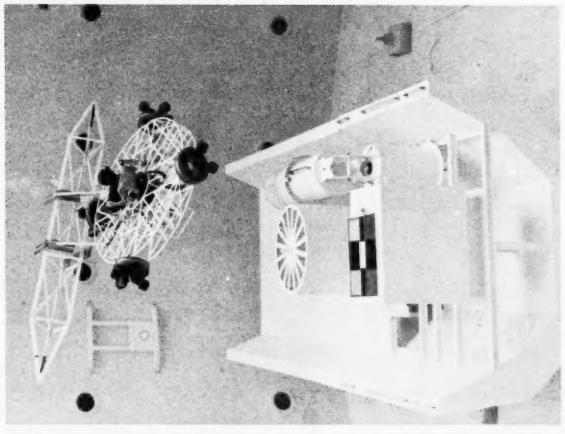


Space Shuttle Maneuver—How the Space Shuttle's *Enterprise* will place the long-duration exposure facility in orbit. The LDEF presently is scheduled as the payload for the first operational flight of the Space Shuttle in 1980.

Launches for 1978—Completed and Projected

Name	Launch Date	Vehicle	Range	Mission Remarks
Intelsat IVA-(F3)	Jan. 6	Atlas-Centaur	ETR	Improved communications satellite for Comsat. Reimbursable.
IUE-A	Jan. 26	Delta	ETR	International Ultraviolet Explorer—cooperative with ESA. Designed to obtain high resolution data on stars and planets in the ultraviolet region of the spectrum.
FLTSATCOM-A	Feb. 9	Atlas-Centaur	ETR	Navy fleet satellite communications. Reimbursable.
Landsat-C	March 5	Delta	WTR	Third Earth resources technology satellite.
Japan/BSE-A	March 23	Delta	ETR	Broadcasting satellite experimental. Japanese communications satellite for conducting TV broadcast experiments. Reimbursable.
Intelsat IVA-F6	April	Atlas-Centaur	ETR	Improved communications satellite for Comsat. Reimbursablie.
AEM-1 (HCMM)	April	Scout	WTR	Heat capacity mapping mission to produce thermal maps for thermal inertial measurements, investigate feasibility of geothermal source location by remote sensing, and provide coverage of snow field for water runoff prediction.
Comstar-C	April	Atlas-Centaur	ETR	Third in a series of domestic communications satellites for Comsat. Reimbursable.
OTS-BU	April	Delta	ETR	ESA orbital Test Satellite.
NOAA/ GOES-C	May	Delta	ETR	Part of global network of geostationary environmental satellites to provide Earth imaging, monitor the space environment, and relay meterological data to users. Reimbursable.
TIROS-N	May	Atlas-F	WTR	Polar orbiting operational spacecraft to provide improve meteorological data for NOMSS and provide support to GARP.
Pioneer Venus-A	May	Atlas-Centaur	ETR	Planetary mission to Venus. Orbiter will measure upper atmosphere and ionosphere, study interaction between solar wind and ionosphere and magnetic field, study atmospheric and surface characteristics, determine gravitational field harmonics.
Seasat-A	May	Atlas-F	WTR	Sea satellite for global monitoring of ocean geoid, wave topography, surface wind speed and direction, ocean surface temperature, and ice field extent and dynamics.
ESA/GEOS-B	June	Delta	ETR	ESA spacecraft to conduct scientific investigation of waves and particles in magnetosphere. Reimbursable.
Japan Backup	June	Delta	ETR	Backup spacecraft for Japan. Reimbursable.
UK-6	July	Scout	WI	United Kingdom spacecraft to measure ultraheavy cosmic ray particles and study low-energy cosmic X-rays and the fast secular behavior of X-ray sources. Reimbursable.

ISEE-C	July	Delta	ETR	International Sun Earth Explorer. An extension of interplanetary studies with the spacecraft toward the Sun sufficiently outside the Earth's influence for comparison with results of ISEE-A and B missions and of probes to outer planets.
Nimbus-G	Aug.	Delta	WTR	Develop and flight test advanced sensors and technology basic to conducting experiments in the pollution monitoring, oceanographic, and meteorological disciplines.
Pioneer Venus-B	Aug.	Atlas-Centaur	ETR	Multiprobe—will determine nature and composition of clouds, composition structure and general circulation pattern of the atmosphere of Venus from the surface to high altitudes, study interaction between planetary environment and interplanetary medium.
Navy-20	Sept.	Scout	WTR	Navy navigation satellite. Reimbursable. (Call-up.)
NATO III-C	Sept.	Delta	ETR	Communications satellite, second in series.
NOAA-A	Sept.	Atlas-F	WTR	Advanced operational prototype spacecraft and sensors for a third generation series of operational meteorological satellites. Reimbursable.
HEAO-B	Oct.	Atlas-Centaur	ETR	Second high energy astronomical observatory to study highly energetic radiation from space.
Telesat-D	Nov.	Delta	ETR	Canadian domestic communications satellite. Reimbursable.
FLTSATCOM-B	Nov.	Atlas-Centaur	ETR	Navy fleet satellite communications. Reimbursable.



Tryout for the Real Thing—An operator hovers over a mockup of the Space Shuttle cargo bay in a demonstration of the "free flyer," a simulated space vehicle fabricated for testing space construction operations. The tests are taking place in the simulated weightless environment of the neutral buoyancy simulator at the Marshal center. The "free flyer"—capable of moving through the water in any direction—is propelled through the 12-meter-deep water by small electric trolling motors that simulate the thrusters to be used in space. A prefabricated steel construction beam is maneuvered by the operator in much the same way an astronaut in a space suit would maneuver in space.

Flagged for Outstanding Record—Kennedy's minuteman flag with two gold stars shining in the bottom left-hand corner is hoisted by center director Lee R. Scherer. He is assisted by KSC security honor guards (left to right) Lt. John Karas, Patrolmen Frank Bossie and Louis DeStefano. Each gold star represents five years of at least 90 percent Civil Service employee participation in the center's U.S. Savings Bond program. KSC is the only NASA center to sustain this percentage for 10 consecutive years.

Patents for Inventions from NASA Research

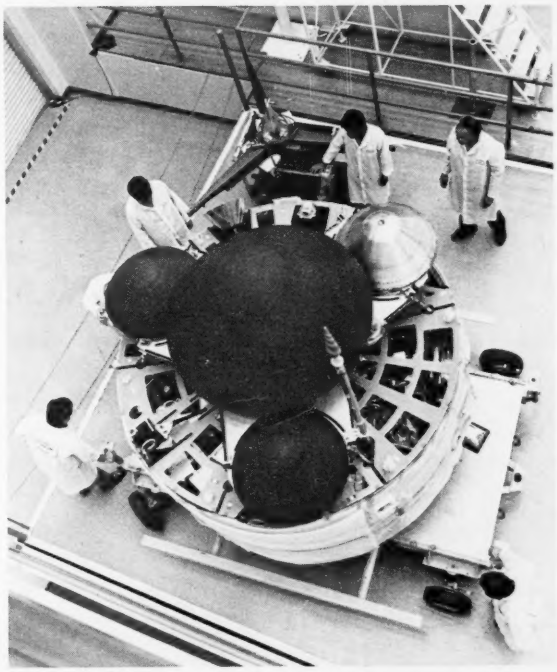
The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Edward F. Baehr, NASA/LERC James E. Burnett, NASA/LERC	Tissue macerating instrument	4,061,146	LERC
Harvey S. Bloomfield, NASA/LERC	In-situ laser retorting of oil shale	4,061,190	LERC
Oran W. Nicks, NASA/LARC	Aircraft total energy sensor	4,061,128	LARC
George G. Mateer, NASA/ARC Aviel Brosh, National Academy of Sciences, Washington, DC	Flow separation detector	4,061,029	ARC
Allan J. Zucnerwar, Old Dominion University, Norfolk, Va.	Differential sound level meter	4,061,041	LARC
Phillip J. Stocker, Rockwell Internation Corp., Canoga Park, Calif.	Laser extensometer	4,061,427	MSFC
Benjamin W. Grunbaum, University of California, Berkeley, Calif.	Automatic multiple-sample applicator and electophoresis apparatus	4,061,561	ARC
Richard A. Wynveen James D. Powell Franz H. Shubert — Life Systems, Inc., Beachwood, Ohio	Iodine Generator for reclaimed water purification	4,061,570	JSC
Charles H. Bell, NASA/KSC	Fiber optic multiplex optical transmission system	4,061,577	KSC
Paul M. Sawko, NASA/ARC Salvatore R. Riccitiello, NASA/ARC	Intumescent coatings containing 4,4-dinitrosulfanilide	4,061,579	ARC
William J. Gilwee, NASA/ARC John A. Parker, NASA/ARC	Honeycomb-laminate composite structure	4,061,812	ARC
Vaclav Hadek Robert B. Somoano Alan Rembaum — NASA/JPL, Pasadena, Calif.	Durable antistatic coating for polymethylmethacrylate	4,061,834	NRLO
Li-Chen Hsu, NASA/LERC	Trimerization of aromatic nitriles	4,061,856	LERC
Ralph D. Thomas, NASA/LERC William J. Nagle, NASA/LERC	Multi-cell battery protection system	4,061,955	LERC
Richard L. Sydnor Jonn W. Macconnell — NASA/JPL, Pasadena, Calif.	Ultra stable frequency distribution system	4,061,974	NRLO
Joseph J. Heyman, NASA/LARC	CW ultrasonic bolt tensioning monitor	4,062,227	LARC
Allen G. Ford, NASA/JPL, Pasadena, Calif.	Motion restraining device	4,062,245	NRLO
Ronald N. Jensen, NASA/LARC	Solar heating system	4,062,347	LARC
Lloyd S. Keafer, Jr., NASA/LARC Ernest E. Burcher, NASA/LARC Leonard P. Kopia, NASA/LARC	Transmitting & reflecting diffuser	4,062,996	LARC
Carroll C. Dailey, NASA/MSFC	Method & means for testing a glancing-incidence mirror system of an X-ray telescope	4,063,088	MSFC
C. Martin Berdahl, NASA/JPL Pasadena, Calif.	Selective image area control of X-ray film exposure density	4,063,092	NRLO
Reginald J. Exton, NASA/LARC	TV fatigue crack monitorial system	4,063,282	LARC
David B. Rhodes, NASA/LARC	Optical scanner	4,063,814	LARC
Marvin D. Rhodes, NASA/LARC Dr. Martin M. Mikulas, Jr. lettice structure	Method of making a composite sandwich	4,063,981	LARC
Charles G. Miller James B. Stephens — NASA/JPL, Pasadena, Calif.	Low cost solar energy collection system	4,065,053	NRLO
George M. Dudley, NASA/LARC	Mono-page paper distributor	4,065,118	LARC

Robert L. Kurtz, NASA/MSFC	Projection system for display of parallex and perspective	4,065,202	MSFC
George E. Dickerson, NASA/LARC	Composite lanination method	4,065,340	LARC
Donald J. Progar, NASA/LARC; Vernon L. Bell, NASA/LARC	Polyimide adhesives	4,065,345	LARC
Terry L. St. Clair, NASA/LARC	Thermoluminescent aerosol analysis	4,062,650	LARC
Albert C. Knoell, NASA/JPL, Pasadena, Calif.	Method of adhering bone to a rigid substrate using a graphite fibet reinforced bone cement	4,064,566	NRLO
Renaldo V. Jenkins, NASA/LARC; Alexander P. Sabol, NASA/LARC	Rotary engine	4,064,841	LARC
James E. Johnson, Tom Foster, Roy D. Allan, General Electric Co., Cincinnati, Ohio	Variable cycle gas turbine engines	4,064,692	LERC
Adam M. Kissiah, Jr., NASA/KSC	Implantable electronic hearing aid	4,063,048	KSC

NASA Programs Outlined—Louis Mogavero, Director of the NASA Technology Utilization Office, describes technology transfer programs to 1,800 delegates from throughout the U.S. and Canada at the Conference on New Technology sponsored by the United Automobile Workers Union skilled trades department in New Orleans. Seated in foreground is Douglas Fraser, UAW President.

Time Does March On—A replica of the historic Lindbergh "Spirit of St. Louis" looks like a child's toy as it flies over the massive vehicle assembly building at the Kennedy Space Center. The monoplane, built by the Experimental Aircraft Assn., is making a commemorative cross-country flight in honor of Charles A. Lindbergh's heroic achievement as the first man to fly in a solo flight from New York to Paris. (Photo courtesy of Kelly Furlong of Melbourne.)



Planet Probers—When the two Pioneer-Venus spacecraft in the first U.S. mission to Venus approach the planet in late 1978, one will eject four scientific probes (here shown in pre-launch preparatory stages) to reach Venus' surface and collect information on the general circulation pattern of the planet's lower atmosphere.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

A Swift and Efficient Tool for Cataract Surgery

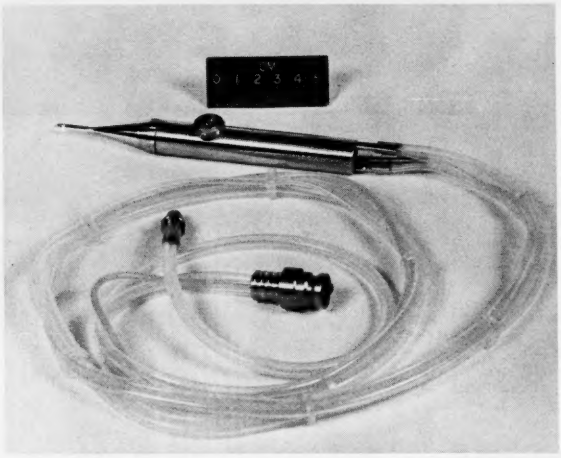
A new optical surgical instrument which has been undergoing extensive laboratory evaluation for some four years is now ready for clinical tests. The instrument was developed by NASA's Lewis Research Center in a joint project with Cleveland eye surgeon Dr. William J. McGannon. Tests of the surgical device for the removal of hard cataracts will be undertaken as part of a co-operative agreement between NASA and the National Eye Institute.

A cataract is a condition in which the lens of the eye becomes opaque, impairing vision and leading to potential blindness. Surgery to remove the cloudy material is necessary to restore vision. About half a million people a year need such surgery in the United States alone. Traditional surgical techniques require a 180-degree incision and then numerous stitches to close it and the possibility of infection keeps patients in the hospital for at least a 10-day recovery period.

In contrast, the new cutting instrument requires only a small opening in the cornea and is believed to be suitable for the full range of hardness of cataracts. The small corneal opening required to remove the cataract serves to reduce convalescent time markedly.

The new system consists of a surgical hand piece, a regulated flow system for infusion fluid, and a peristaltic outflow pump with necessary controls. The surgical hand piece contains a high-speed air turbine drive, a tiny augur type of cutter with both end and side-cutting capability, and inflow and outflow passages. The tip of the hand piece is 2.38 millimeters at outside diameter and 1.57 mm inside diameter. The cutter rotates at speeds of from 30,000 to 270,000 rpm. The heart of the control system for the infusion fluid is a flow-sensing pressure regulator that maintains intra-ocular pressure under widely varying flow conditions.

The recent agreement calls for clinical trials of the device to be carried out by the Eye Research Institute of the Retina Foundation in Boston, which has been evaluating the instrument for several years. The National Eye Institute also will select other eye research centers as participants in the clinical trials.



NASA
National Aeronautics and Space Administration